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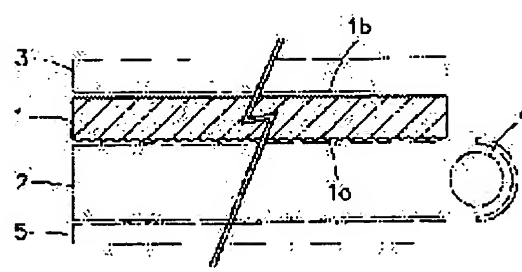
(54) LIGHT DIFFUSING SHEET

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a light diffusing sheet in which the quantity of light from one surface is larger, the loss in light is suppressed, uniformly diffused light with no irregularity in the luminance can be emitted from the other surface, and no wrinkles are produced even when the sheet is heated by the light and heat from the light source and which can be easily manufactured.



SOLUTION: The sheet 1 is made of a light-transmitting resin having rough patterns on both surfaces 1a, 1b of the sheet in such a manner that the average roughness of one surface 1a where light enters is higher than the average roughness of the other surface 1b where the light exits and that the surface area rate of the one surface 1a is smaller than the surface area rate of the other surface 1b. The average surface roughness of one surface ranges from 0.3 to 5.0 μm, the surface roughness of the other surface 1b ranges from 0.3 to 1.5 μm, the surface area rate of one surface 1a ranges from 1.001 to 1.080, and the surface area rate of the other surface 1b ranges from 1.010 to 1.250. A light-diffusing agent having 0.5 to 50 μm average particle size may be incorporated by 0.1 to 2.0 wt.% into the light-transmitting resin.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical diffusion sheet used for the back light unit of a liquid crystal display, an electric-spectaculars signboard, lighting covering, an arcade, a lighting plate, the eye hiding plate of a balcony, etc.
[0002]
[Description of the Prior Art] The general back light unit of a liquid crystal display consists of this optical light guide plate [with which the dot for optical diffusion was printed by the rear face], light source [which has been arranged at one side or the both sides of this light guide plate], optical diffusion sheet [which was piled up on these light guide plates (cold cathode tube etc.)], and diffusion sheet top, or a lens film (prism sheet) piled up up and down.
[0003] The optical diffusion sheet built into this back light unit prevents diffusing the light from a light guide plate in homogeneity, and a dot being able to be seen in the display screen, or achieves the duty which suppresses optical loss and emits the diffused light to homogeneity to a liquid crystal panel side.
[0004] As such an optical diffusion sheet, at least on one side of ** transparence base material While performing embossing to one side or both sides of a sheet (patent No. 2665301) and ** transparence plastic film in which the optical diffusion layer which contains a polymer bead and a non-subtlety particle as a light diffusion agent was prepared and forming irregularity in them The sheet (patent No. 2562265) which formed random irregularity in the front face without making the sheet (JP,11-337711,A) and ** light diffusion agent which prepared the optical diffusion layer containing a particle in one side or both sides contain is known.
[0005]
[Problem(s) to be Solved by the Invention] However, the polymer bead which projects from the front face of an optical diffusion layer, and the non-subtlety particle damaged the lens film piled up on it, for the dedropping-from optical diffusion layer, and cone reason, visibility was inadequate by the impact etc., the grace of a display fell, and the optical diffusion sheet of ** had problems, like a manufacturing cost worsens [the yield] highly.
[0006] Moreover, although diffusibility has been improved with the irregularity formed in one side or both sides, since the optical diffusion layer containing a particle was prepared in the front face, the optical diffusion sheet of ** had the same problem as the optical diffusion sheet of **, and since it needed two processes of the concavo-convex formation process by embossing, and the formation process of an optical diffusion layer, it had the problem that a manufacturing cost increased.
[0007] Moreover, the optical diffusion sheet of ** had the problem that light scattering becomes uneven, brightness varied partially or the dot of a surface of light-guard plate could be [**** / that light scattering is inadequate in the shape of toothing of the front face formed in one side or both sides being unsuitable] seen. Moreover, it became hot with the light and the heat from the light source, and there was also a problem that a wrinkle occurred on an optical diffusion sheet.
[0008] The place which this invention is made in view of the above-mentioned problem, and is made into the purpose has much close quantity of light from one side, and is to offer the easy optical diffusion sheet of manufacture which suppresses optical loss few and can emit the uniform diffused light without the variation in brightness from an opposite side. Moreover, even if it becomes hot with the light and the heat from the light source, a wrinkle does not occur, but other purposes have little optical loss, and are to offer the optical diffusion sheet which is stabilized and performs uniform optical diffusion.
[0009]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the optical diffusion sheet concerning claim 1 of this invention Are larger than the average side granularity of the opposite side where the average side granularity of one side which irregularity is formed in sheet both sides and turns into a light entering surface serves as a light exiting surface. And it is the sheet with which the rate of surface area of this one side consists of translucency resin

smaller than the rate of surface area of this opposite side. Average side granularity of this one side is characterized by the rate of surface area of 0.3-1.5 micrometers and this one side being [the rates of surface area of 1.001-1.080, and this opposite side] 1.010-1.250 for the average side granularity of 0.3-5.0 micrometers and this opposite side.
[0010] "Average side granularity" is JIS here. B It extends to three dimensions so that center line average-of-roughness-height Ra defined by 0601 can be applied to a measuring plane, and it is "the value which averaged the absolute value of the deflection from the datum level to the appointed side", and is computed by the following formula.
[0011]
[Equation 1]

$$Ra = \frac{1}{So}\int_{Y_B}^{Y_T}\int_{X_L}^{X_R} | F(X,Y) - Zo | dXdY$$

[0012] The inside of a formula and Ra are average side granularity and S0. The datum-level product of a measuring plane and F (X, Y) are JISB. The granularity curve and Z0 which developed to the field f (x) defined by 0601 The height of datum level is shown.
[0013] And "the rate of surface area" means the rate (S/S0) of the actual surface area S to the area S0 when assuming that a measuring plane is a flat side.
[0014] It is required to be easy to enter in a sheet equally [abbreviation of a lot of / in order to suppress optical loss few and to make the uniform diffused light without the variation in brightness emit / light from one side of an optical diffusion sheet], and for the opposite side to which light comes out to be excellent in an optical diffusion. While making it a lot of light enter equally [abbreviation] from this one side by making concavo-convex distribution density coarse while making the difference of elevation of the irregularity of one side used as a light entering surface larger than the irregularity of an opposite side, the optical diffusion sheet of claim 1 By preventing interference and diffraction of light and on the other hand distributing small and densely the difference of elevation of the irregularity of the opposite side used as a light exiting surface from the irregularity of one side, the diffused light which raises the optical diffusion of an opposite side and is emitted out of a panel is returned to a panel inside, and it serves to reduce optical loss.
[0015] Namely, the optical diffusion sheet of claim 1 has average side granularity Ra of one side used as a light entering surface larger than that of an opposite side. Since it is in the range of 0.3-5.0 micrometers, and the rate of surface area of this one side is smaller than that of an opposite side and is in the range of 1.001-1.080, The irregularity of this one side is the difference of elevation (magnitude) and distribution density suitable for ON light with an equal abbreviation, and so, if this optical diffusion sheet is piled up on the light guide plate of for example, a back light unit Since the great portion of light which progresses while reflecting the interior of a light guide plate moderately enters into a sheet equally [abbreviation] from whole one side of a sheet, optical loss hardly produces little partial variation of the close quantity of light, either. And average side granularity Ra of the opposite side used as the light exiting surface of this optical diffusion sheet is smaller than that of above-mentioned one side. Since it is in the range of 0.3-1.5 micrometers, and the rate of surface area of this opposite side is larger than that of above-mentioned one side and it is in the range of 1.010-1.250, The irregularity of this opposite side serves as the concavo-convex magnitude and distribution density which were distributed densely finely and were suitable for dispersion of light from the irregularity of above-mentioned one side, and so, it can emit the diffused light without the variation in brightness, making homogeneity diffuse light enough with the irregularity of this opposite side.
[0016] In the above-mentioned optical diffusion sheet, if 1.030-1.070, and the rate of surface area of an opposite side are set [the average side granularity of one side / 1.0-3.0 micrometers and the average side granularity of an opposite side] to 1.050-1.200 for 0.5-1.5 micrometers, nothing, and the rate of surface area of one side as indicated to claim 2, optical diffusion becomes much more good and can emit the more uniform diffused light.
[0017] Next, the optical diffusion sheet concerning claim 3 of this invention is characterized by the light diffusion agent containing in the translucency resin in above-mentioned claim 1 or the optical diffusion sheet of 2.
[0018] Since the light which entered into the sheet from one side diffuses such an optical diffusion sheet also with a light diffusion agent, its optical diffusion improves further. Moreover, since a wrinkle does not occur on a sheet even if telescopic motion of a sheet becomes small and is heated with the light from the light source by the light diffusion agent, it can be stabilized and the uniform diffused light can be emitted.
[0019] If the above-mentioned light diffusion agent has the mean particle diameter of 0.5-50 micrometers and contains it 0.1 to 20% of the weight in translucency resin as indicated to claim 4, it will become good [diffusion] much more [it], without checking transparency of light. Moreover, telescopic motion of the sheet by the heat from the light source can decrease, the formation of wrinkles can be stopped enough, and the stable diffused light can be acquired.
[0020]
[Embodiment of the Invention] Hereafter, the concrete operation gestalt of this invention is explained based on a drawing.

[0021] Drawing 1 is the sectional view of the optical diffusion sheet concerning 1 operation gestalt of this invention.
[0022] This optical diffusion sheet 1 is a sheet which consists of translucency resin with which irregularity was formed in sheet both sides 1a and 1b. A polycarbonate with total light transmission high as translucency resin, polyester, Polyethylene, polypropylene, a polyolefine copolymer (for example, Polly 4-methyl pentene-1 grade), A polyvinyl chloride, annular polyolefine (for example, cyclo polyolefine etc.), Since thermal resistance was soft the good top, when thermoplastics, such as acrylic resin, polystyrene, and an ionomer, was used preferably, and especially polypropylene is built into a liquid crystal display, Since it does not deform to heat dissipation of the light source and an upper lens film (prism sheet) is not damaged, it is used preferably.
[0023] Distribution density has become [the difference of elevation] larger than the irregularity formed in opposite side (top face) 1b from which the irregularity formed in one side (inferior surface of tongue) 1a used as the light entering surface of this optical diffusion sheet 1 serves as a light exiting surface coarsely. That is, this one side 1a has average side granularity Ra larger than that of opposite side 1b, is in the range of 0.3-5.0 micrometers, and its rate of surface area (S/S0) is smaller than that of opposite side 1b, and it is in the range of 1.001-1.080.
[0024] On the other hand, you make it distributed finely and densely rather than the irregularity by which the irregularity formed in opposite side (top face) 1used as light exiting surface b was formed in above-mentioned one side 1a, average side granularity Ra is smaller than that of one side 1a, and it is in the range of 0.3-1.5 micrometers, and the rate of surface area (S/S0) is larger than that of one side 1b, and it is in the range of 1.010-1.250.
[0025] The total light transmission can use such an optical diffusion sheet 1 as the sheet which also makes the Hayes value penetrate, becoming 60 - 95% and diffusing light well 94% or more (110 micrometers in thickness).
[0026] After this optical diffusion sheet 1 carries out extrusion molding of the thermoplastics (what blended various additives if needed) of a raw material to the shape of a film thru/or a sheet, it can be efficiently manufactured by the approach of forming irregularity in sheet both sides with the up-and-down crimp attachment roll with which the fineness of a crimp differs. In addition, well-known approaches, such as pressing a film and a sheet with the press plate which has irregularity, forming them, or inserting into the crimp attachment roll of the upper and lower sides of this coating layer, and forming irregularity after spreading of a coating, are adopted. In addition, although the thickness of a sheet is not limited, in the case of the optical diffusion sheet used for the back light unit of a liquid crystal display, it is desirable to fabricate in thickness of about 0.025-1mm.
[0027] As shown in drawing 1 , pile up the above-mentioned optical diffusion sheet 1 on a light guide plate 2, and on it, in piles, if incidence of the light is carried out to a light guide plate 2 from the light source 4 of light guide plate 2 flank, as mentioned already, the lens film 3 Since the irregularity of one side 1a of the optical diffusion sheet 1 is the difference of elevation (magnitude) and distribution density suitable for ON light, While reflection and the light which progresses while acting as Idemitsu enter into the optical diffusion sheet 1 equally [abbreviation] from the whole one side 1a of a sheet 1 and optical loss decreases, it stops also almost producing the partial variation of the close quantity of light for the interior of a light guide plate 2 moderately. And since the irregularity of opposite side 1b of this sheet 1 serves as the concavo-convex magnitude and distribution density which were distributed densely finely and were suitable for dispersion of light from the irregularity of the above-mentioned one side 1a, in the optical diffusion sheet 1, the light which carried out ON light is fully diffused with the irregularity of this opposite side 1b, and the more uniform diffused light is emitted to the direction of the lens film 3. Therefore, the dot of light guide plate 2 rear face can be seen, or producing the variation in partial brightness is lost. In addition, 5 is a reflective sheet and is for carrying out ON light of the light which acts as Idemitsu caudad from a light guide plate 2 into a light guide plate 2 again.
[0028] When it becomes small, and it is less than 0.3 micrometers, the rate of surface area of sheet one side 1a (S/S0) becomes larger than that of opposite side 1b and average side granularity Ra of sheet one side 1a exceeds 1.080 from that of opposite side 1b, the scattered reflection in sheet one side 1a increases, dissipation of the light from light guide plate 2 end face etc. takes place, the close quantity of light to a sheet 1 decreases, and brightness falls. Moreover, when average side granularity Ra of sheet one side 1a is less than 0.3 micrometers and the rate of surface area (S/S0) is less than 1.001 Since the air space of the interface of this one side 1a and a light guide plate 2 becomes very thin, the light which progressed to the light guide plate 2 from the light source 4 hardly reflects regularly, and it is not spread to a distant place by specular reflection and the optical defect by interference, diffraction, etc. of light arises Conversely, although much light carries out ON light to a sheet 1 from the part near the light source 4 of a light guide plate 2 and the brightness of the part becomes high, since ON light only of the slight light is carried out to a sheet 1 but the brightness of the part falls, the whole is covered and the variation in brightness is produced from a part far from the light source of a light guide plate 2. Since it furthermore sticks too much with a light guide plate, deterioration of display grace, such as a blot of the color by interference of light etc., takes place.
[0029] If average side granularity Ra of opposite side 1b of a sheet 1 becomes larger than 1.5 micrometers and the rate of surface area (S/S0) becomes small from 1.010, since optical diffusion will become inadequate on the other hand, field luminescence with them becomes difficult. [there are many diffused-light components and uniform]

[0030] Especially average side granularity Ra of the above-mentioned sheet one side 1a 1.0-3.0 micrometers, If average side granularity of 1.030-1.070, nothing, and sheet opposite side 1b is set to 0.5-1.5 micrometers and the rate of surface area is set to 1.050-1.200, the rate of surface area The optical diffusibility ability of this sheet 1 improves remarkably, without brightness falling, since the light fully scattered about from sheet opposite side 1b is emitted, it becomes the uniform diffused light and variation is not produced in brightness.
[0031] In addition, even if it piles up the lens film 3, this lens film 3 does not almost get [of one optical diffusion sheet which has the irregularity in which the tip had a radius of circle] damaged, and it is used preferably. Moreover, there is also use which raises effectiveness by piling up the optical diffusion sheet 1 of two sheets so that the lens film 3 may be inserted.
[0032] Drawing 2 is the sectional view of the optical diffusion sheet concerning other operation gestalten of this invention.
[0033] Light diffusion agent 1c distributes and contains this optical diffusion sheet 10 in homogeneity in translucency resin. It contains in order to control heat telescopic motion of a sheet 10 and to lose the formation of wrinkles, while light diffusion agent 1c raises the diffusibility of light, and the minerals particle of the bead of translucency synthetic resin or translucency from which the translucency resin which constitutes a sheet 10, and an optical refractive index differ is used. As this light diffusion agent 1c, it is independent respectively, or they are used by metallic oxides, such as organic polymer particles, such as inorganic particles, such as a silica, a mica, synthetic mica, a calcium carbonate, a magnesium carbonate, a barium sulfate, talc, a montmorillonite, kaolin clay, a bentonite, and hectorite, an acrylic bead, a styrene bead, and benzoguanamine, titanium oxide, a zinc oxide, and an alumina, etc., for example, combining two or more sorts.
[0034] As for the above-mentioned light diffusion agent 1c, that 0.1-100 micrometers of 0.5-50 micrometers of the mean particle diameter of whose are 1-15 micrometers most preferably is used. If particle size is smaller than 0.1 micrometers, since it is easy to condense, even if dispersibility is bad and is able to distribute to homogeneity, the wavelength of light will be larger and dispersion effectiveness will worsen. Therefore, a particle with a magnitude [1.0 more micrometers or more] of about 0.5 micrometers or more is desirable. Moreover, if particle size is larger than 100 micrometers, since light scattering becomes an ununiformity and a fall and particle of light transmission can be seen, it is not desirable. Therefore, the particle of the magnitude to 15 more micrometers of the magnitude to 50 micrometers is desirable.
[0035] The content of light diffusion agent 1c is preferably good most preferably to consider as about 3 - 15 % of the weight 0.1 to 20% of the weight 0.05 to 40% of the weight. If it becomes less than 0.05 % of the weight, optical diffuser efficiency is not expectable, and when it increases more than 40 % of the weight, the amount of transparency of light decreases in the absorption and reflection by the particle, a display stops being able to be visible easily through an optical diffusion sheet, deterioration of quality is produced, and it stops being equal to use on the other hand.
[0036] the sheet with which, as for the optical diffusion sheet 10 which made homogeneity contain the silica system light diffusion agent whose particle size is 1-15 micrometers preferably 0.1 to 20% of the weight about the silica system light diffusion agent whose particle size is 0.5-50 micrometers three to 15% of the weight, the total light transmission does not contain a light diffusion agent, and abbreviation -- it becomes the same, and a haze value becomes high, and it can be used as a back light unit of a liquid crystal display as an optical diffusion sheet excellent in the concealment nature which penetrates light well.
[0037] Furthermore, if homogeneity is made to carry out distributed content of the light diffusion agent 1c, heat telescopic motion of the optical diffusion sheet 10 is controlled, even if the optical diffusion sheet 10 is heated by the heat of the light source 4, elongation becomes small, and even if the optical diffusion sheet 10 is being fixed, the formation of wrinkles can be stopped. Even in this case, if the content of a light diffusion agent is within the limits of the above, it is enough.
[0038] It has the advantage that telescopic motion of a sheet 10 is controlled by light diffusion agent 1c, and the formation of wrinkles is prevented while its optical diffusion improves further, since the light which entered into the sheet 10 from one side 1a diffuses the optical diffusion sheet 10 which made light diffusion agent 1c contain as mentioned above also with a light diffusion agent.
[0039] Next, the still more concrete example of this invention is explained.
[0040] After carrying out extrusion molding of the [example 1] polypropylene resin to the shape of a sheet with a thickness of 110 micrometers, it let between the up-and-down crimp attachment rolls with which the fineness of a crimp differs pass, and the optical diffusion sheet which has irregularity to both sides was produced.
[0041] WYKO surface type-like measuring device NT- when 2000 [the product made from WYKO] was used and average side granularity Ra was measured about the above-mentioned optical diffusion sheet in 230.6x175.4-micrometer measuring range, Ra of the opposite side where Ra of one side used as a light entering surface serves as 0.445 micrometers and a light exiting surface was 0.305 micrometers.

[0042] Furthermore, when the probe microscope [the Seiko Instruments make] was used, and surface area was measured about the above-mentioned optical diffusion sheet in 400x400-micrometer measuring range and having been asked for the rate of surface area (S/S0), 1.0064 and the rate of surface area of an opposite side of the rate of surface area of one side were 1.0239.
[0043] Subsequently, when total light transmission and the Hayes value were measured about the above-mentioned optical diffusion sheet using hazemeter [HGMby Suga Test Instruments Co., Ltd.]-2DP, total light transmission was 95.0% and the Hayes value was 62.4%.
[0044] moreover, the place which laid the above-mentioned optical diffusion sheet on the light guide plate of the back light unit for liquid crystal displays, turned on the light source, put luminance-meter nt-1"p by Minolta Co., Ltd. on the distance of 22cm from the optical diffusion sheet, and measured brightness -- 94.3 cd/m2 it was . Moreover, when it observed visually whether the dot on the rear face of a light guide plate would be concealed by coincidence, the dot was concealed completely, and was not visible and dot concealment nature was good.
[0045] The optical diffusion sheet which has irregularity to both sides was produced like the example 1 except having used the up-and-down crimp attachment roll with which the fineness of a crimp differs from the crimp attachment roll of the [example 2] example 1.
[0046] Average side granularity Ra of this optical diffusion sheet, the rate of surface area (S/S0), total light transmission, The place measured like the example 1 about the Hayes value, brightness, and the concealment nature of a dot, Average side granularity Ra of the opposite side where average side granularity Ra of one side used as a light entering surface serves as 0.642 micrometers and a light exiting surface 0.322 micrometers, 96.4 cd/m2 and the concealment nature of a dot were [1.0385 and total light transmission / the Hayes value / brightness] good [the rate of surface area of one side / 1.0077 and the rate of surface area of an opposite side] 64.5% 95.1%.
[0047] The measurement result of the above examples 1 and 2 is collectively indicated to the following table 1.
[0048] Four kinds of following optical diffusion sheets which have irregularity to both sides were produced like the example 1 except having used the up-and-down crimp attachment roll with which the fineness of the [examples 1-4 of comparison] crimp differs.
[0049] ** The optical diffusion sheet 0.321 micrometers and whose average side granularity Ra of an opposite side average side granularity Ra of one side is 0.052 micrometers (the rate of surface area is not measured), ** The optical diffusion sheet 0.331 micrometers and whose average side granularity Ra of an opposite side average side granularity Ra of one side is 0.328 micrometers (the rate of surface area is not measured), 0.394 micrometers and average side granularity Ra of an opposite side ** 0.286 micrometers, [average side granularity Ra of one side] The optical diffusion sheet 1.0043 and whose rate of surface area of an opposite side the rate of surface area of one side is 1.0141, ** The optical diffusion sheet 1.0032 and whose rate of surface area of an opposite side 1.007 micrometers and the rate of surface area of one side are [average side granularity Ra of one side] 1.0068 for 1.248 micrometers and average side granularity Ra of an opposite side.
[0050] And it measured like [nature / the total light transmission of the optical diffusion sheet of these **s - ** the Hayes value, brightness, and / of a dot / concealment] the example 1, and the result was written together to the following table 1.
[0051]
[Table 1]

	平均面粗さ(μm)		表面積率		全光線透過率(%)	ヘイズ値(%)	輝度(cd/m²)	ドットの隠蔽性
	片面(入光面)	反対面(出光面)	片面(入光面)	反対面(出光面)				
実施例1	0.445	0.305	1.0064	1.0239	95.0	62.4	94.3	○
実施例2	0.642	0.322	1.0077	1.0385	95.1	64.5	96.4	○
比較例1	0.321	0.052	–	–	93.2	86.5	72.7	×
比較例2	0.331	0.328	–	–	93.4	91.3	74.8	×
比較例3	0.394	0.286	1.0043	1.0141	94.2	53.3	80.3	×
比較例4	1.248	1.007	1.0032	1.0068	89.4	20.2	70.5	×

[0052] In addition, among Table 1, the concealment nature of O of a dot is good, it is shown that a dot is not checked by looking, and x shows that the concealment nature of a dot is bad and the dot was checked by looking.
[0053] When this table 1 is seen, the average side granularity of one side (light entering surface) is larger than that of an opposite side (light exiting surface). Within the limits whose average side granularity of one side the rate of surface area of one side is smaller than that of an opposite side, and is 0.3-5.0 micrometers, The rate of surface area of within the limits whose average side granularity of an opposite side is 0.3-1.5 micrometers, and one side Within the limits of 1.001-1.080, For the optical diffusion sheet of the examples 1 and 2 of this invention which has the rate of surface area

of an opposite side within the limits of 1.010-1.250, total light transmission is as high as 95% or more, the Hayes value is as moderate as 62.4% and 64.5%, and brightness is 94 cd/m2. It is as high as the above and the concealment nature of a dot is also good.

[0054] On the other hand, even if the average side granularity of one side (light entering surface) is larger than that of an opposite side (light exiting surface) Substantially, also although total light transmission and the Hayes value are good, the optical diffusion sheet of the example 1 of a comparison which is less than the range whose average side granularity of an opposite side is 0.3-1.5 micrometers, and double-sided average side granularity the same optical diffusion sheet of the example 2 of a comparison Brightness is 72.7 cd/m2 and 74.8 cd/m2. It turns out that it is low and dot concealment nature is also bad.

[0055] Moreover, even if the optical diffusion sheet of the example 3 of a comparison with which the average side granularity of an opposite side (light exiting surface) does not fill the conditions of this invention even if the double-sided rate of surface area fulfills the conditions of this invention, and double-sided average side granularity fulfill the conditions of this invention The optical diffusion sheet of the examples 3 and 4 of a comparison with which the rate of surface area of an opposite side does not fill the conditions of this invention is understood that brightness is low too and the concealment nature of a dot is also bad.

[0056] As opposed to the polypropylene resin used in the [examples 3-8] example 1 mean particle diameter -- a silica system light diffusion agent (4 micrometers and 8 micrometers) (the Fuji SHIRISHIA chemistry incorporated company make --) As it reaches silo FO big 505 and is shown in the following table 2, 4004 1.5 % of the weight, After adding 10% of the weight and mixing to homogeneity 5% of the weight 2.5% of the weight, extrusion molding was carried out to the shape of a sheet with a thickness of 110 micrometers, and the optical diffusion sheet which has irregularity to sheet both sides was produced using the crimp attachment roll other than the crimp attachment roll used in the example 1. In addition, the optical diffusion sheet of the same thickness which does not contain the above-mentioned light diffusion agent at all as an example 5 of a comparison was produced using the same crimp attachment roll.

[0057] While measuring the total light transmission and the Hayes value of these optical diffusion sheets like the example 1, average side granularity and the rate of surface area were measured like the example 1 about some optical diffusion sheets, and the measurement result was collectively indicated to the following table 2. Furthermore, while measuring the rate of linear expansion in Shimadzu 50 [apparatus-for-thermomechanical-analysis TMA-] about each optical diffusion sheet of examples 7 and 8 and the example 5 of a comparison, the tension elastic modulus in 60 degrees C was measured about the optical diffusion sheet of examples 4, 7, and 8 and the example 5 of a comparison, and the result was also written together to Table 2. This tension modulus of elasticity is measured with the dynamic viscoelasticity equipment RSA made from LEO metric scientific EFU I. moreover, the constant temperature maintained at the conditions of the temperature of 60 degrees C, and 90% of humidity where it cut each optical diffusion sheet in the fixed dimension and four points of the corner are fixed -- it writes together to Table 2 also about the result of having observed the condition of the optical diffusion sheet after leaving it for ten days in constant humidity equipment visually. In addition, in Table 2, x shows, respectively that the wrinkle generated on the sheet that, as for **, the wrinkle generated slightly that O did not have the formation of wrinkles around the fixed portion.

[0058]

[Table 2]

	光拡散剤		全光線透過率(%)	ヘイズ値(%)	平均面粗さ(μm)		表面積率		線膨張率(60~65℃)(×10⁻⁶℃)	皺の有無	引張り弾性率(MPa)
	粒径(μm)	配合量(重量%)			片面	反対面	片面	反対面			
実施例3	4	1.5	100	87.6	–	–	–	–	–	×	–
実施例4	4	2.5	100	90.3	–	–	–	–	–	△	227
実施例5	8	1.5	100	90.7	–	–	–	–	–	△	–
実施例6	8	2.5	100	91.0	–	–	–	–	–	○	–
実施例7	8	5.0	100	91.4	1.530	1.289	1.053	1.102	30.1	○	264
実施例8	8	10.0	100	92.3	1.503	1.126	1.056	1.153	30.7	○	490
比較例5	–	–	100	86.5	0.231	0.376	1.014	1.004	50.9	×	196

[0059] When this table 2 was seen, total light transmission showed the value as 100% also with the optical diffusion sheet of the example 5 of a comparison same [the optical diffusion sheet of examples 3-8]. The reason has strong light

scattering of each sheet, and in case total light transmission is measured by the hazemeter, since it reflected, and the scattered light overlapped and was measured, it is guessed. On the other hand, to the sheet of the example 5 of a comparison of the Hayes value being 86.5%, the sheet of examples 3-8 is 87.6 - 92.3%, and is high no less than 1.1 to 5.8%, and it turned out that it is the optical diffusion sheet excellent in the concealment nature which penetrates light well. Especially the sheet of the examples 5 and 6 which blended the light diffusion agent whose mean particle diameter is 8 micrometers Even if mean particle diameter compares the light diffusion agent which is 4 micrometers with the sheet of the examples 3 and 4 which carried out tales-doses addition The sheet of the examples 5-8 which the Hayes value is high 3.1% and no less than 0.7%, and blended the light diffusion agent with a mean particle diameter of 8 micrometers compared with the sheet of the example 5 of a comparison It turns out that the Hayes value is high no less than 4.2 to 5.8%, and the thing with a mean particle diameter of 8 micrometers is excellent as a light diffusion agent. The mean particle diameter of a light diffusion agent has 5-10 micrometers better than this.

[0060] Moreover, the rate of linear expansion of the sheet of examples 7 and 8 is very small with 30.1% and 30.7% compared with the rate of linear expansion of the sheet of the example 5 of a comparison, respectively, and even if it becomes hot with the heat of the light source, it turns out that elongation is the sheet which a wrinkle cannot generate easily small. furthermore, constant temperature -- in a wrinkling trial with constant humidity equipment, it turns out that the formation of wrinkles is improved except for the sheet of an example 3, and the formation of wrinkles is lost even if the formation of wrinkles is not especially seen with the sheet of examples 6, 7, and 8 but it becomes hot by the light source in real use. In addition, the particle size of a light diffusion agent is understood that 8 micrometers is good also in this wrinkling trial. Furthermore, the sheet of the examples 7 and 8 which blended the light diffusion agent with a mean particle diameter of 8 micrometers is the sheet with which the tension elastic modulus at the time of a 60-degree C elevated temperature is also high with a sheet, has the drag force by deformation, and has rigidity further, and it turns out that it is the sheet which a wrinkle cannot generate easily.

[0061] Heat telescopic motion of a sheet is small and this result shows that a wrinkle does not occur, even if it uses the optical diffusion sheet containing a light diffusion agent for the back light unit of a liquid crystal display etc. and becomes hot with the light from the light source.

[0062]

[Effect of the Invention] The optical diffusion sheet of this invention has much close quantity of light from one side, optical loss is suppressed few, the uniform diffused light with little variation in brightness can be emitted from an opposite side, and concealment nature does so the remarkable effectiveness that it is good and can manufacture easily so that clearly from the above explanation. Moreover, since the formation of wrinkles can be controlled that are and it contracts hard to expand even if it can make the Hayes value high, it can raise concealment nature and it becomes hot by the light source, the optical diffusion sheet which the light diffusion agent contained can be used suitable for the back light unit of a liquid crystal display.

[Translation done.]

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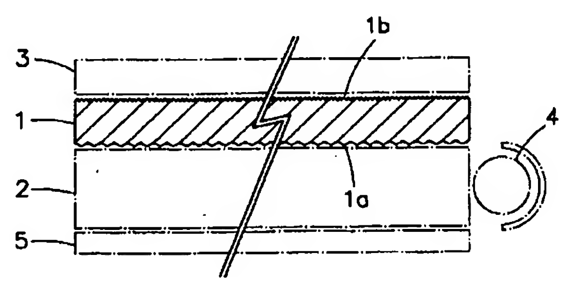
最終頁に続く

(54)【発明の名称】　光拡散シート

(57)【要約】
【課題】　片面からの入光量が多く、光損失を少なく抑えて、反対面から輝度のバラツキのない均一な拡散光を放出でき、光源からの光と熱によって熱せられても皺が発生しない、製造の容易な光拡散シートを提供する。
【解決手段】　シート両面１ａ，１ｂに凹凸が形成され、入光面となる片面１ａの平均面粗さが出光面となる反対面１ｂの平均面粗さよりも大きく、且つ、該片面１ａの表面積率が該反対面１ｂの表面積率よりも小さい透光性樹脂からなるシート１であり、該片面１ａの平均面粗さが０．３～５．０μｍ、該反対面１ｂの平均面粗さが０．３～１．５μｍ、該片面１ａの表面積率が１．００１～１．０８０、該反対面１ｂの表面積率が１．０１０～１．２５０である光拡散シートとする。透光性樹脂中に、０．５～５０μｍの平均粒径を有する光拡散剤を０．１～２．０重量%含有させてもよい。



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【特許請求の範囲】

【請求項１】　シート両面に凹凸が形成され、入光面となる片面の平均面粗さが出光面となる反対面の平均面粗さよりも大きく、且つ、該片面の表面積率が該反対面の表面積率よりも小さい透光性樹脂からなるシートであって、該片面の平均面粗さが０．３～５．０μｍ、該反対面の平均面粗さが０．３～１．５μｍ、該片面の表面積率が１．００１～１．０８０、該反対面の表面積率が１．０１０～１．２５０であることを特徴とする光拡散シート。

【請求項２】　前記片面の平均面粗さが１．０～３．０μｍ、前記反対面の平均面粗さが０．５～１．５μｍであり、前記片面の表面積率が１．０３０～１．０７０、前記反対面の表面積率が１．０５０～１．２００であることを特徴とする請求項１に記載の光拡散シート。

【請求項３】　前記透光性樹脂中に光拡散剤が含有されていることを特徴とする請求項１又は請求項２に記載の光拡散シート。

【請求項４】　光拡散剤が０．５～５０μｍの平均粒径を有し、透光性樹脂中に０．１～２０重量％含有されていることを特徴とする請求項３に記載の光拡散シート。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、液晶ディスプレイのバックライトユニットや電飾看板、照明カバー、アーケード、採光板、バルコニーの目隠し板などに用いられる光拡散シートに関する。

【０００２】

【従来の技術】液晶ディスプレイの一般的なバックライトユニットは、裏面に光拡散用のドットが印刷された導光板と、この導光板の片側又は両側に配置された光源（冷陰極管等）と、この導光板の上に重ねられた光拡散シートと、この光拡散シートの上又は上下に重ねられたレンズフィルム（プリズムシート）等で構成されている。

【０００３】斯かるバックライトユニットに組み込まれる光拡散シートは、導光板からの光を均一に拡散し、表示画面でドットが見えるのを防いだり、光損失を抑えて拡散光を液晶パネル面へ均一に放出する役目を果たすものである。

【０００４】このような光拡散シートとしては、①透明基材の少なくとも片面に、光拡散剤としてポリマービーズや無機微粒子を含む光拡散層を設けたシート（特許第２６６５３０１号）、②透明プラスチックフィルムの片面又は両面にエンボス加工を施して凹凸を形成すると共に、微粒子を含む光拡散層を片面又は両面に設けたシート（特開平１１－３３７７１１号）、③光拡散剤を含有させないで表面にランダムな凹凸を形成したシート（特許第２５６２２６５号）等が知られている。

【０００５】

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【発明が解決しようとする課題】しかしながら、①の光拡散シートは、光拡散層の表面から突出するポリマービーズや無機微粒子が、その上に重ねられるレンズフィルムを傷つけたり、衝撃などにより光拡散層から脱落しやすいため、鮮明度が不充分であったり、表示の品位が低下したり、歩留りがわるく製造コストが高くなる、などの問題があった。

【０００６】また、②の光拡散シートは、片面又は両面に形成した凹凸によって拡散性が改善されるとは言うものの、微粒子を含む光拡散層が表面に設けられているので①の光拡散シートと同様の問題があり、しかも、エンボスによる凹凸形成工程と光拡散層の形成工程との２工程を必要とするため、製造コストが増大するという問題があった。

【０００７】また、③の光拡散シートは、片面又は両面に形成した表面の凹凸形状が不適切であると、光散乱が不十分であったり、光散乱が不均一となり部分的に輝度がばらついたり、導光板面のドットが見えるという問題があった。また、光源からの光と熱により熱せられて、光拡散シートに皺が発生するという問題もあった。

【０００８】本発明は上記の問題に鑑みてなされたものであり、その目的とするところは、片面からの入光量が多く、光損失を少なく抑えて、反対面から輝度のバラツキのない均一な拡散光を放出できる、製造の容易な光拡散シートを提供することにある。また、他の目的は、光源からの光と熱によって熱せられても皺が発生せず、光損失が少なく、安定して均一な光拡散を行う光拡散シートを提供することにある。

【０００９】

【課題を解決するための手段】上記目的を達成するため、本発明の請求項１に係る光拡散シートは、シート両面に凹凸が形成され、入光面となる片面の平均面粗さが出光面となる反対面の平均面粗さよりも大きく、且つ、該片面の表面積率が該反対面の表面積率よりも小さい透光性樹脂からなるシートであって、該片面の平均面粗さが０．３～５．０μｍ、該反対面の平均面粗さが０．３～１．５μｍ、該片面の表面積率が１．００１～１．０８０、該反対面の表面積率が１．０１０～１．２５０であることを特徴とするものである。

【００１０】ここに「平均面粗さ」とは、ＪＩＳ　Ｂ　０６０１で定義されている中心線平均粗さＲａを、測定面に対して適用できるよう三次元に拡張したものであって、「基準面から指定面までの偏差の絶対値を平均した値」であり、次の数式により算出されるものである。

【００１１】

【数１】

$$Ra=\frac{1}{S_0}\int_{Y_B}^{Y_T}\int_{X_L}^{X_R}\left|F(X,Y)-Z_0\right|dXdY$$

【００１２】式中、Ｒａは平均面粗さ、S_0 は測定面の

基準面積、F（X，Y）はJISB　0601で定義されているf（x）を面に展開した粗さ曲線、Z_0 は基準面の高さを示す。

【0013】そして、「表面積率」とは、測定面が平坦面であると仮定したときの面積S_0に対する実際の表面積Sの割合（S/S_0）をいう。

【0014】光損失を少なく抑えて、輝度のバラツキのない均一な拡散光を放出させるためには、光拡散シートの片面から多量の光が略均等にシート内に入りやすいこと、光の出る反対面が光拡散作用に優れることが必要である。請求項1の光拡散シートは、入光面となる片面の凹凸の高低差を反対面の凹凸より大きくすると共に凹凸の分布密度を粗くすることによって、該片面から多量の光が略均等に入るようにすると共に、光の干渉や回折を防ぎ、一方、出光面となる反対面の凹凸の高低差を片面の凹凸より小さく且つ密に分布させることによって、反対面の光拡散作用を高め、かつパネル外に放出される拡散光をパネル内面へ戻し、光損失を低減する働きをさせたものである。

【0015】即ち、請求項1の光拡散シートは、入光面となる片面の平均面粗さRaが反対面のそれより大きく、0．3～5．0μmの範囲にあり、且つ、この片面の表面積率が反対面のそれより小さく、1．001～1．080の範囲にあるため、この片面の凹凸が略均等な入光に適した高低差（大きさ）及び分布密度になっており、それ故、この光拡散シートを例えばバックライトユニットの導光板の上に重ねると、導光板の内部を適度に反射しながら進む光の大部分が、シートの片面全体から略均等にシート内へ入るので、光損失は少なく入光量の部分的なバラツキも殆ど生じない。そして、この光拡散シートの出光面となる反対面の平均面粗さRaは上記片面のそれより小さく、0．3～1．5μmの範囲にあり、且つ、この反対面の表面積率は上記片面のそれより大きく、1．010～1．250の範囲にあるため、この反対面の凹凸は上記片面の凹凸よりも細かく密に分布して光の散乱に適した凹凸の大きさ及び分布密度となっており、それゆえ、この反対面の凹凸によって光を均一に充分拡散させながら輝度のバラツキのない拡散光を放出することができる。

【0016】上記の光拡散シートにおいて、請求項2に記載したように、片面の平均面粗さを1．0～3．0μm、反対面の平均面粗さを0．5～1．5μmとなし、片面の表面積率を1．030～1．070、反対面の表面積率を1．050～1．200にすると、光拡散が一層良好になり、より均一な拡散光を放出することができる。

【0017】次に、本発明の請求項3に係る光拡散シートは、上記請求項1又は2の光拡散シートにおいて、その透光性樹脂中に光拡散剤が含有されていることを特徴とするものである。

【0018】このような光拡散シートは、片面からシート内へ入った光が光拡散剤によっても拡散されるため、光拡散作用が一層向上する。また、シートの伸縮が光拡散剤によって小さくなり、光源からの光で熱せられてもシートに皺が発生しないので、均一な拡散光を安定して放出することができる。

【0019】上記の光拡散剤は、請求項4に記載したように、0．5～50μmの平均粒径を有し、透光性樹脂中に0．1～20重量%含有されていると、光の透過が阻害されることなく拡散が一層良好となる。また、光源からの熱によるシートの伸縮が減少して皺の発生を充分抑えることができ、安定した拡散光を得ることができる。

【0020】

【発明の実施の形態】以下、図面に基づいて本発明の具体的な実施形態を説明する。

【0021】図1は本発明の一実施形態に係る光拡散シートの断面図である。

【0022】この光拡散シート1は、シート両面1a，1bに凹凸が形成された透光性樹脂からなるシートである。透光性樹脂としては、全光線透過率の高いポリカーボネート、ポリエステル、ポリエチレン、ポリプロピレン、ポリオレフィン共重合体（例えばポリ－4－メチルペンテン－1等）、ポリ塩化ビニル、環状ポリオレフィン（例えばシクロポリオレフィン等）、アクリル樹脂、ポリスチレン、アイオノマーなどの熱可塑性樹脂が好ましく使用され、特にポリプロピレンは耐熱性が良好であるうえ、柔らかいから、液晶ディスプレイに組み込まれたとき、光源の放熱に対して変形することがないし、上側のレンズフィルム（プリズムシート）を傷付けたりすることがないので好ましく用いられる。

【0023】この光拡散シート1の入光面となる片面（下面）1aに形成された凹凸は、出光面となる反対面（上面）1bに形成された凹凸よりも高低差が大きく分布密度が粗くなっている。即ち、この片面1aは、平均面粗さRaが反対面1bのそれよりも大きく、0．3～5．0μmの範囲にあり、且つ、表面積率（S/S_0）が反対面1bのそれよりも小さく、1．001～1．080の範囲にある。

【0024】これに対し、出光面となる反対面（上面）1bに形成された凹凸は、上記片面1aに形成された凹凸よりも細かく密に分布させてあり、平均面粗さRaが片面1aのそれよりも小さく0．3～1．5μmの範囲にあり、表面積率(S/S_0)が片面1bのそれよりも大きく1．010～1．250の範囲にある。

【0025】このような光拡散シート1は、その全光線透過率が94%以上（厚さ110μm）、ヘイズ値も60～95%となり、光を良く拡散させながら透過させるシートとすることができる。

【0026】斯かる光拡散シート1は、例えば、原料の

熱可塑性樹脂（必要に応じて各種添加剤を配合したもの）をフィルムないしシート状に押出成形したのち、シボの細かさが異なる上下のシボ付けロールでシート両面に凹凸を形成する方法により、効率良く製造することができる。その他、フィルムやシートを凹凸を有するプレス板で押圧して形成したり、塗料の塗布後に該塗料層を上下のシボ付けロールに挟んで凹凸を形成したりする等、公知の方法が採用される。尚、シートの厚さは限定されないが、液晶ディスプレイのバックライトユニットに用いる光拡散シートの場合は、０．０２５～１ｍｍ程度の厚さに成形することが好ましい。

【００２７】上記の光拡散シート１を図１に示すように導光板２の上に重ね、その上にレンズフィルム３を重ねて、導光板２側部の光源４から光を導光板２に入射すると、既述したように、光拡散シート１の片面１ａの凹凸が入光に適した高低差（大きさ）及び分布密度になっているため、導光板２の内部を適度に反射、出光しながら進む光がシート１の片面１ａ全体から略均等に光拡散シート１内へ入り、光損失が少なくなると共に、入光量の部分的なバラツキも殆ど生じなくなる。そして、このシート１の反対面１ｂの凹凸は、上記片面１ａの凹凸よりも細かく密に分布して光の散乱に適した凹凸の大きさ及び分布密度となっているため、光拡散シート１内に入光した光は、この反対面１ｂの凹凸によって充分に拡散され、より均一な拡散光がレンズフィルム３の方へ放出される。従って、導光板２裏面のドットが見えたり、部分的な輝度のバラツキを生じることはなくなる。なお、５は反射シートであって、導光板２から下方に出光する光を再度導光板２内に入光させるためのものである。

【００２８】シート片面１ａの平均面粗さＲａが反対面１ｂのそれより小さくなって０．３μｍを下回り、シート片面１ａの表面積率（S/S_0）が反対面１ｂのそれより大きくなって１．０８０を越える場合は、シート片面１ａでの乱反射が増して導光板２端面からの光の散逸などが起こり、シート１への入光量が減少して、輝度が低下する。また、シート片面１ａの平均面粗さＲａが０．３μｍを下回り、表面積率（S/S_0）が１．００１を下回る場合は、該片面１ａと導光板２との界面の空気層が極めて薄くなり、光源４から導光板２へ進んだ光がほとんど正反射せず、正反射によって遠方へ伝播されず、また光の干渉や回折などによる光学欠陥が生じるので、導光板２の光源４に近い部分から多くの光がシート１に入光してその部分の輝度が高くなるが、逆に、導光板２の光源から遠い部分からは僅かの光しかシート１に入光せずその部分の輝度が低下するため、全体に亘って輝度のバラツキを生じる。さらに導光板と密着しすぎるので、光の干渉などによる色のにじみなど表示品位の低下が起こる。

【００２９】一方、シート１の反対面１ｂの平均面粗さＲａが１．５μｍより大きくなり、表面積率（S/S_0）が１．０１０より小さくなると、光拡散が不充分になるため、拡散光成分が多く均一な面発光が難しくなる。

【００３０】特に、上記のシート片面１ａの平均面粗さＲａを１．０～３．０μｍ、その表面積率を１．０３０～１．０７０となし、シート反対面１ｂの平均面粗さを０．５～１．５μｍ、その表面積率を１．０５０～１．２００にすると、該シート１の光拡散性能が著しく向上し、シート反対面１ｂから十分に散乱した光が放出されるため、輝度が低下することなく、均一な拡散光となって輝度にバラツキを生じない。

【００３１】尚、先端が丸みをもった凹凸を有する光拡散シート１は、レンズフィルム３を重ねても該レンズフィルム３が傷つくことは殆どなく、好ましく用いられる。またレンズフィルム３を挟むように２枚の光拡散シート１を重ねることにより、効果を向上させる使用もある。

【００３２】図２は本発明の他の実施形態に係る光拡散シートの断面図である。

【００３３】この光拡散シート１０は、透光性樹脂中に光拡散剤１ｃが均一に分散して含有されている。光拡散剤１ｃは、光の拡散性を向上させると共にシート１０の熱伸縮を抑制して皺の発生をなくすために含有されるものであって、シート１０を構成する透光性樹脂と光屈折率が異なる透光性合成樹脂のビーズや透光性の無機質粒子が使用される。かかる光拡散剤１ｃとしては、例えばシリカ、マイカ、合成マイカ、炭酸カルシウム、炭酸マグネシウム、硫酸バリウム、タルク、モンモリロナイト、カオリンクレー、ベントナイト、ヘクトライト等の無機粒子、アクリルビーズ、スチレンビーズ、ベンゾグアナミン等の有機ポリマー微粒子、酸化チタン、酸化亜鉛、アルミナ等の金属酸化物などが、それぞれ単独で又は二種以上組み合わせて使用される。

【００３４】上記の光拡散剤１ｃは、その平均粒径が０．１～１００μｍ、より好ましくは０．５～５０μｍ、最も好ましくは１～１５μｍであるものが使用される。粒径が０．１μｍより小さいと、凝集しやすいために分散性が悪く、均一に分散できたとしても光の波長の方が大きくて散乱効率が悪くなる。そのために０．５μｍ程度以上の、更には１．０μｍ以上の大きさの粒子が好ましいのである。また、粒径が１００μｍより大きいと、光散乱が不均一になるし、光線透過率の低下や粒子が見えたりするので好ましくない。そのため、５０μｍまでの大きさの、更には１５μｍまでの大きさの粒子が好ましいのである。

【００３５】光拡散剤１ｃの含有量は０．０５～４０重量%、好ましくは０．１～２０重量%、最も好ましくは３～１５重量%程度とするのが良い。０．０５重量%より少なくなると、光拡散効率が期待できず、一方、４０重量%より多くなると、粒子による吸収・反射で光の透

過量が少なくなり、光拡散シートを通して表示が見えにくくなったりして品質の低下を生じ、使用に耐えなくなる。

【0036】粒径が0．5～50μmのシリカ系光拡散剤を0．1～20重量％、好ましくは粒径が1～15μmのシリカ系光拡散剤を3～15重量％均一に含有させた光拡散シート10は、その全光線透過率が光拡散剤を含まないシートと略同じとなり、且つ、ヘーズ値が高くなり、光を良く透過する隠蔽性に優れた光拡散シートとして、液晶ディスプレイのバックライトユニットとして使用できる。

【0037】更に、光拡散剤1ｃを均一に分散含有させると、光拡散シート10の熱伸縮が抑制されて、光源4の熱により光拡散シート10が熱せられても伸びが小さくなり、たとえ光拡散シート10が固定されていても皺の発生を抑えることができる。この場合でも、光拡散剤の含有量は上記の範囲内であれば十分である。

【0038】上記のように光拡散剤1ｃを含有させた光拡散シート10は、片面1ａからシート10内へ入った光が光拡散剤によっても拡散されるため、光拡散作用が一層向上すると共に、光拡散剤1ｃによりシート10の伸縮が抑制されて皺の発生が防止されるといった利点を有する。

【0039】次に、本発明の更に具体的な実施例を説明する。

【0040】［実施例1］ポリプロピレン樹脂を厚さ110μmのシート状に押出成形したのち、シボの細かさが異なる上下のシボ付けロールの間を通して、両面に凹凸を有する光拡散シートを作製した。

【0041】WYKO表面形状測定装置NT－2000［WYKO（株）製］を使用し、上記の光拡散シートについて、230．6×175．4μmの測定範囲で平均面粗さRａを測定したところ、入光面となる片面のRａは0．445μm、出光面となる反対面のRａは0．305μmであった。

【0042】更に、プローブ顕微鏡［セイコーインスツルメンツ（株）製］を使用し、上記の光拡散シートについて、400×400μmの測定範囲で表面積を測定し、表面積率（S/S_0）を求めたところ、片面の表面積率は1．0064、反対面の表面積率は1．0239であった。

【0043】次いで、上記の光拡散シートについて、ヘイズメーター〔スガ試験機(株)製〕HGM－2DPを用いて全光線透過率とヘイズ値を測定したところ、全光線透過率は95．0％、ヘイズ値は62．4％であった。

【0044】また、上記の光拡散シートを液晶ディスプレイ用のバックライトユニットの導光板の上に載置して光源を点灯し、光拡散シートから22ｃｍの距離にミノルタ（株）製の輝度計ｎｔ－1°ｐを置いて輝度を測定したところ、94．3ｃｄ／m^2 であった。また、同時に導光板裏面のドットが隠蔽されるかどうかを目視で観察したところ、ドットは完全に隠蔽されて見えることがなく、ドット隠蔽性は良好であった。

【0045】［実施例2］実施例1のシボ付けロールとはシボの細かさが異なる上下のシボ付けロールを用いた以外は実施例1と同様にして、両面に凹凸を有する光拡散シートを作製した。

【0046】この光拡散シートの平均面粗さRａ、表面積率（S/S_0）、全光線透過率、ヘイズ値、輝度、ドットの隠蔽性について、実施例1と同様に測定したところ、入光面となる片面の平均面粗さRａは0．642μm、出光面となる反対面の平均面粗さRａは0．322μm、片面の表面積率は1．0077、反対面の表面積率は1．0385、全光線透過率は95．1％、ヘイズ値は64．5％、輝度は96．4ｃｄ／m^2 、ドットの隠蔽性は良好であった。

【0047】以上の実施例1，2の測定結果を下記の表1にまとめて記載する。

【0048】［比較例1～4］シボの細かさが異なる上下のシボ付けロールを用いた以外は実施例1と同様にして、両面に凹凸を有する下記の4種類の光拡散シートを作製した。

【0049】① 片面の平均面粗さRａが0．321μm、反対面の平均面粗さRａが0．052μmである光拡散シート（表面積率は測定せず）、

② 片面の平均面粗さRａが0．331μm、反対面の平均面粗さRａが0．328μmである光拡散シート（表面積率は測定せず）、

③ 片面の平均面粗さRａが0．394μm、反対面の平均面粗さRａが0．286μm、片面の表面積率が1．0043、反対面の表面積率が1．0141である光拡散シート、

④ 片面の平均面粗さRａが1．248μm、反対面の平均面粗さRａが1．007μm、片面の表面積率が1．0032、反対面の表面積率が1．0068である光拡散シート。

【0050】そして、これら①～④の光拡散シートの全光線透過率、ヘイズ値、輝度、ドットの隠蔽性について実施例1と同様に測定し、その結果を下記表1に併記した。

【0051】

【表1】

	平均面粗さ(μm)		表面積率		全光線透過率(%)	ヘイズ値(%)	輝度(cd/m²)	ドットの隠蔽性
	片面(入光面)	反対面(出光面)	片面(入光面)	反対面(出光面)				
実施例1	0.445	0.305	1.0064	1.0239	95.0	62.4	94.3	○
実施例2	0.642	0.322	1.0077	1.0385	95.1	64.5	96.4	○
比較例1	0.321	0.052	−	−	93.2	86.5	72.7	×
比較例2	0.331	0.328	−	−	93.4	91.3	74.8	×
比較例3	0.394	0.286	1.0043	1.0141	94.2	53.3	80.3	×
比較例4	1.248	1.007	1.0032	1.0068	89.4	20.2	70.5	×

【００５２】尚、表１中、○はドットの隠蔽性が良好でドットが視認されないことを示し、×はドットの隠蔽性が悪くドットが視認されたことを示す。

【００５３】この表１を見ると、片面（入光面）の平均面粗さが反対面（出光面）のそれより大きく、片面の表面積率が反対面のそれより小さく、片面の平均面粗さが０．３～５．０μｍの範囲内、反対面の平均面粗さが０．３～１．５μｍの範囲内、片面の表面積率が１．００１～１．０８０の範囲内、反対面の表面積率が１．０１０～１．２５０の範囲内にある本発明の実施例１，２の光拡散シートは、全光線透過率が９５％以上と高く、ヘイズ値が６２．４％及び６４．５％と適度であり、輝度が９４ｃｄ／ｍ² 以上と高く、ドットの隠蔽性も良好である。

【００５４】これに対し、片面（入光面）の平均面粗さが反対面（出光面）のそれより大きくても、反対面の平均面粗さが０．３～１．５μｍの範囲を下回る比較例１の光拡散シートや、両面の平均面粗さが実質的に同一である比較例２の光拡散シートは、全光線透過率とヘイズ値は良いけれども、輝度が７２．７ｃｄ／ｍ² 、７４．８ｃｄ／ｍ² と低く、ドット隠蔽性も悪いことが判る。

【００５５】また、両面の表面積率が本発明の条件を満たしていても、反対面（出光面）の平均面粗さが本発明の条件を満たさない比較例３の光拡散シートや、両面の平均面粗さが本発明の条件を満たしていても、反対面の表面積率が本発明の条件を満たさない比較例３，４の光拡散シートは、やはり輝度が低く、ドットの隠蔽性も悪いことが判る。

【００５６】〔実施例３～８〕実施例１で使用したポリプロピレン樹脂に対して、平均粒径が４μｍと８μｍの＊シリカ系光拡散剤（富士シリシア化学株式会社製、サイロフォービック５０５および４００４）を、下記の表２に示すように１．５重量％、２．５重量％、５重量％、１０重量％添加し均一に混合した後、厚さ１１０μｍのシート状に押出成形し、実施例１で使用したシボ付けロールとは別のシボ付けロールを用いて、シート両面に凹凸を有する光拡散シートを作製した。なお、比較例５として、上記の光拡散剤を全く含まない同じ厚さの光拡散シートを同じシボ付けロールを用いて作製した。

【００５７】これらの光拡散シートの全光線透過率とヘイズ値を実施例１と同様に測定すると共に、一部の光拡散シートについて平均面粗さと表面積率を実施例１と同様に測定し、その測定結果を下記の表２にまとめて記載した。さらに、実施例７，８及び比較例５の各光拡散シートについて、その線膨脹率を島津製作所製の熱機械分析装置ＴＭＡ－５０にて測定すると共に、実施例４，７，８及び比較例５の光拡散シートについて６０℃での引張り弾性率を測定し、その結果も表２に併記した。この引張り弾性率は、レオメトリック・サイエンティフィック・エフ・イー製の動的粘弾性装置ＲＳＡで測定したものである。また、各光拡散シートを一定寸法に切断し、その角部の４点を固定した状態で、温度６０℃、湿度９０％の条件に保たれた恒温恒湿装置内に１０日間放置した後の光拡散シートの状態を目視で観察した結果についても、表２に併記する。尚、表２において、○は皺の発生がないことを、△は固定部分の周囲に僅かに皺が発生したことを、×は皺がシートに発生したことを、それぞれ示す。

【００５８】

【表２】

	光拡散剤 粒径(μm)	光拡散剤 配合量(重量%)	全光線透過率(%)	ヘイズ値(%)	平均面粗さ(μm) 片面	平均面粗さ(μm) 反対面	表面積率 片面	表面積率 反対面	線膨張率(60-65℃)($\times10^{-6}$/℃)	皺の有無	引張り弾性率(MPa)
実施例3	4	1.5	100	87.6	－	－	－	－	－	×	－
実施例4	4	2.5	100	90.3	－	－	－	－	－	△	227
実施例5	8	1.5	100	90.7	－	－	－	－	－	△	－
実施例6	8	2.5	100	91.0	－	－	－	－	－	○	－
実施例7	8	5.0	100	91.4	1.530	1.289	1.053	1.102	30.1	○	264
実施例8	8	10.0	100	92.3	1.503	1.126	1.056	1.153	30.7	○	490
比較例5	－	－	100	86.5	0.231	0.376	1.014	1.004	50.9	×	196

【0059】この表2を見ると、全光線透過率は実施例3～8の光拡散シートも比較例5の光拡散シートも100％と同じ値を示した。その理由は、各シートの光散乱が強く、ヘイズメーターで全光線透過率を測定する際に、散乱光が反射し重複して測定されたためと推測される。一方、ヘイズ値は、比較例5のシートが86．5％であるのに対し、実施例3～8のシートは87．6～92．3％で、1．1～5．8％も高くなっており、光を良く透過する隠蔽性に優れた光拡散シートであることがわかった。特に、平均粒径が8μmの光拡散剤を配合した実施例5，6のシートは、平均粒径が4μmの光拡散剤を同量添加した実施例3，4のシートに比べても、3．1％及び0．7％もヘイズ値が高くなっており、また、比較例5のシートに比べると、平均粒径8μmの光拡散剤を配合した実施例5～8のシートは、4．2～5．8％もヘイズ値が高くなっており、光拡散剤としては、平均粒径8μmのものが優れていることがわかる。このことより、光拡散剤の平均粒径は5～10μmが良好である。

【0060】また、実施例7，8のシートの線膨張率は、比較例5のシートの線膨張率に比べて、それぞれ30．1％、30．7％と非常に小さくなっており、光源の熱で熱せられても伸びが小さく皺が発生しにくいシートであることがわかる。さらに、恒温恒湿装置での皺発生試験では、実施例3のシートを除いて皺の発生が改善され、特に実施例6，7，8のシートでは皺の発生が見られず、実使用において光源で熱せられても皺の発生がなくなることがわかる。なお、光拡散剤の粒径は、この皺発生試験においても8μmが良好であることがわかる。さらに、平均粒径8μmの光拡散剤を配合した実施例7，8のシートは、60℃の高温時の引張り弾性率も＊高く、変形による抵抗力があり、さらに剛性のあるシートとなっており、皺が発生しにくいシートであることがわかる。

【0061】この結果から、光拡散剤を含有した光拡散シートは、液晶ディスプレイのバックライトユニット等に使用して光源からの光で熱せられても、シートの熱伸縮が小さく、皺が発生しないことがわかる。

【0062】

【発明の効果】以上の説明から明らかなように、本発明の光拡散シートは、片面からの入光量が多く、光損失を少なく抑えて、反対面から輝度のバラツキの少ない均一な拡散光を放出でき、隠蔽性が良好で、容易に製造することができるといった顕著な効果を奏する。また、光拡散剤が含有された光拡散シートは、ヘイズ値を高くして隠蔽性を向上させることができ、光源で熱せられても伸縮しにくく皺の発生を抑制することができるので、液晶ディスプレイのバックライトユニットに好適に使用できる。

【図面の簡単な説明】

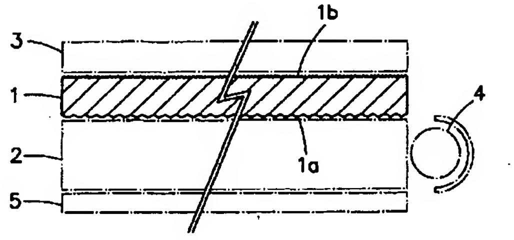
【図1】本発明の一実施形態に係る光拡散シートの断面図である。

【図2】本発明の他の実施形態に係る光拡散シートの断面図である。

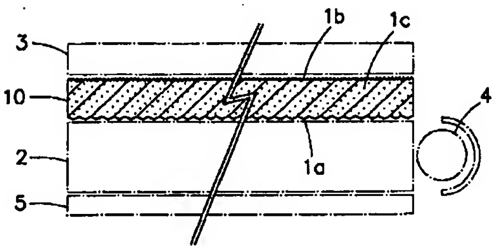
【符号の説明】

1，10　光拡散シート
1a　入光面となる片面（下面）
1b　出光面となる反対面（上面）
1c　光拡散剤
2　導光板
3　レンズフィルム（プリズムシート）
4　光源

【図1】



【図2】



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OPTICAL SHEET AND BACKLIGHT UNIT THAT USES THE SAME
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Patent Claims

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Claim 1

An optical sheet which is an optical sheet in possession of a transparent substrate layer & an optical layer(s) bearing an optical function(s) and which is characterized by the additional lamination of a transparent metal oxide film bearing electroconductivity.

Claim 2

An optical sheet mentioned in Claim 1 wherein the aforementioned metal oxide film has been laminate by means of deposition.

Claim 3

An optical sheet mentioned in Claim 2 wherein ITO is used as the metal oxide constituting the aforementioned metal oxide film.

Claim 4

An optical sheet mentioned in Claim 1, Claim 2, or Claim 3 wherein the surface resistance of the aforementioned metal oxide film is 5 Ω/□ or above and 500 Ω/□ or below.

Claim 5

An optical sheet mentioned in any one of Claims 1 through 4 wherein the aforementioned metal oxide film has been laminated on the front surface and/or rear surface of the substrate layer.

Claim 6

An optical sheet mentioned in any one of Claims 1 through 4 wherein the aforementioned metal oxide film has been laminated on the front surface and/or rear surface thereof.

Claim 7

An optical sheet mentioned in any one of Claims 1 through 6 wherein the aforementioned optical layer possesses a binder and a light diffusion agent dispersed within said binder.

Claim 8

An optical sheet mentioned in any one of Claims 1 through 6 wherein the aforementioned optical layer possesses a striped triangular prism unit.

Claim 9

An optical sheet mentioned in any one of Claims 1 through 8 which additionally possesses, on the side opposite the optical layer side of the aforementioned substrate layer, an anti-sticking layer formed by dispersing beads within a binder.

Claim 10

A backlight unit for a liquid crystal display device which is a backlight unit for a liquid crystal display device designed to disperse beams emitted from a lamp and guide the same toward the front surface side thereof and which is characterized by the possession of the optical sheet mentioned in any one of Claims 1 through 9.

Detailed explanation of the invention

[0001]

(Technical fields to which the invention belongs)

The present invention concerns an optical sheet endowed with specified optical functions (e.g., diffusion, collection, refraction, reflection, etc.) and suitable, above all, for backlight units for liquid crystal display devices as well as a backlight unit that uses the same.

[0002]

(Prior art)

The backlight format whereby a liquid crystal layer is illuminated from behind for inducing light emission has become popularized for liquid crystal display devices, according to which a backlight unit is orchestrated on the lower plane side of a liquid crystal layer. Such a backlight unit (20) is generally constituted, as Figure 3 (a) indicates, to possess a bar-shaped lamp (21) provided as a light source, a light guide panel (22) of a rectangular shape configured in a state where the terminal unit thereof parallels said lamp (21), and multiple optical sheets (23) laminated on the front surface side of said light guide panel (22). These respective optical sheets (23) serve specified optical functions (e.g., refraction, diffusion, etc.) and are concretely instantiated by a light diffusion sheet (24)

configured on the front surface side of the light guide panel (22), a prism sheet (25) configured on the front surface side of the light diffusion sheet (24), etc.

[0003]

The functions of this backlight unit (20) will be explained; first, incident beams arriving at the light guide panel (22) from the lamp (21) become reflected not only by reflective dots or reflective sheets (not shown in the figure) on the rear plane of the light guide panel (22) but also by the respective profile planes thereof and then emitted from the front surface of the light guide panel (22). Beams exiting the front surface of the light guide panel (22) arrive at and are then diffused by the light diffusion sheet (24), as a result of which they become emitted from the front surface of the light diffusion sheet (24). Beams subsequently exiting the light diffusion sheet (24) arrive at the prism sheet (25), whereas beams bearing a distribution wherein the peak thereof coincides with a virtually straight upward direction become emitted from the prism unit (25a) formed on the front surface of the prism sheet (25). Beams emitted from the lamp (21) thus become diffused by the light diffusion sheet (24), become refracted by the prism sheet (25) in such a way to yield a peak coinciding with a virtually straight upward direction, and then illuminate the entire plane of a liquid crystal layer positioned further above (not shown in the figure).

[0004]

Within another known backlight unit not shown in the figure, furthermore, such optical sheets (23) as a light diffusion sheet, prism sheet, etc. are further configured in consideration of the beam collection characteristics of the above-mentioned prism sheet (25), etc.

[0005]

One constituted to possess a substrate layer (26) made of a transparent synthetic resin and an optical layer (27) capable of diffusing light & laminated on the front surface of said substrate layer (26) is being generally used as the light diffusion sheet (24), as Figure 3 (b) indicates, whereas said optical layer (27) bears a structure provided by dispersing a light diffusion agent (29) (e.g., resin beads, glass beads, etc.) within a binder (28). Moreover, one constituted to possess, either as an integrated unit or separate entities, a substrate layer made of a transparent synthetic resin & a triangular prism unit (equivalent to an optical layer) (25a) abutting, as a striped pattern, from the front surface of said substrate layer is being used as the prism sheet (25), as Figure 3 (a) indicates. In other words, the optical sheets (23) of the backlight unit (20) are constituted to serve specified optical functions, and thus, there exist, at present, none to which functions other than optical functions have deliberately been assigned.

[0006]

(Problems to be solved by the invention)

A liquid crystal display device with which the aforementioned backlight unit (20) has been integrated, on the other hand, may become accompanied by such inconveniences as blurs, flickers, etc. on the liquid crystal display screen under the pervasion of electromagnetic waves generated from the lamp (21), inverter, etc. as well as action errors of other instruments under the pervasion of said electromagnetic waves as noises. Attempts have been made in the prior art, for the purpose of preventing such inconveniences, to shield electromagnetic waves by outfitting an ITO deposition film on a liquid crystal display device or by configuring, on the same, a copper sheet or a tape of a gold foil, silver foil, copper foil, etc. These electromagnetic wave shield mechanisms, however, entail, due to the additional orchestration of a component(s) other than optical functional components, not only thickness & weight gains of the liquid crystal display device but also possible proliferations of beam losses.

[0007]

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The objective of the present invention, which has been conceived in acknowledgment of these inconveniences, is to provide an optical sheet capable of shielding electromagnetic waves as well as a backlight unit capable of mitigating the

thickness & weight of a liquid crystal display device and beam losses.

[0008]

(Mechanism for solving the problems)

One invention conceived for the purpose of solving the aforementioned problems concerns an optical sheet which is an optical sheet in possession of a transparent substrate layer & an optical layer(s) bearing an optical function(s) and which is characterized by the additional lamination of a transparent metal oxide film bearing electroconductivity. The "substrate layer" as it is hereby referred to signifies a layer for ensuring the strength, shape, etc. of an optical sheet, whereas the "optical layer" signifies a layer designed to serve a specified optical function such as diffusion, collection, refraction, reflection, etc., although a case where both layers have been integrally formed without clear-cut boundaries is conceptually encompassed as well. Moreover, the "transparency" represents a concept not limited to colorless transparency but encompassing colored transparency, semi-transparency, etc. as well.

[0009]

Not only are specified optical functions served by the optical layer(s) of said optical sheet but electromagnetic waves generated from a lamp, etc. can also be shielded by a concomitantly laminated metal oxide film bearing electroconductivity. It therefore becomes possible to

prevent effects of electromagnetic waves such as blurs, flickers, etc. on liquid crystal display screens, action errors of other instruments, etc. Since the metal oxide film orchestrated for shielding electromagnetic waves is transparent, furthermore, beam losses attributed to the metal oxide film can be minimized, and accordingly, the aforementioned optical functions remain unhindered.

[0010]

It is desirable for the aforementioned metal oxide film to be laminated by means of deposition. It becomes possible, according to such a deposition measure, to laminate a thin & dense metal oxide. For this reason, the aforementioned electromagnetic wave shield function becomes facilitated, and the beam loss mitigation function of the metal oxide film also becomes facilitated.

[0011]

It is desirable to use ITO as the metal oxide constituting the aforementioned metal oxide film. Said ITO (indium-tin oxide) bears an excellent electroconductivity & transparency and is suitable as an electromagnetic wave shield material to be laminated on the optical sheet.

[0012]

It is desirable for the surface resistance of the aforementioned metal oxide film to be 5 Ω/□ or above and 500 Ω/□ or below. In a case where the surface resistance of the metal oxide film laminated on the optical sheet is thus confined to the aforementioned range, it becomes possible to

ensure the effectiveness of the aforementioned electromagnetic wave shield function.

[0013]

The aforementioned metal oxide film may be safely laminated on the front surface and/or rear surface of the substrate layer. The front & rear surfaces of a substrate layer are normally flat, and therefore, the lamination of a metal oxide on such a substrate layer affords the maximal manufacturing ease. Since the strength, heat resistance, etc. of the substrate layer are the highest among all constituent materials of the optical sheet, furthermore, it becomes possible to elevate, to the highest possible level, the temperature of the lamination target (i.e., substrate layer) on an occasion for laminating the metal oxide film and, as a result, not only to up the electroconductivity of the metal oxide film but also to improve the electromagnetic wave shield function.

[0014]

The aforementioned metal oxide film may, on the other hand, be laminated on a prevailing front surface and/or rear surface (i.e., front surface and/or rear surface of optical sheet). It becomes possible, in a case where a metal oxide film is thus laminated on the outer plane of the optical sheet, to ensure the effectiveness of the aforementioned electromagnetic wave shield function.

[0015]

It is desirable to laminate the aforementioned metal oxide film on a so-called "bead-coated light diffusion sheet" wherein the aforementioned optical layer includes a binder & a light diffusion agent dispersed within said binder. Since the essential function of the light diffusion agent is the homogeneous diffusion of transmission beams, light diffusion hindrances are minimal even if the transparency somewhat becomes attenuated as a result of the lamination of the metal oxide film.

[0016]

It is also possible to laminate the aforementioned metal oxide film on a prism sheet wherein the aforementioned optical layer possesses a striped triangular prism unit. Such a prism sheet is normally configured on the front surface of a backlight unit, and therefore, it becomes possible, in a case where the aforementioned metal oxide film is laminated on the prism sheet according to this mechanism, to shield electromagnetic waves at the position closest to the liquid crystal panel and to effectively inhibit flickers & blurs on the liquid crystal screen.

[0017]

It is also possible to configure, on the side opposite the optical layer side of the aforementioned substrate layer, an anti-sticking layer formed by dispersing beads within a binder. The sticking of said optical sheet and a light guide panel. etc. configured atop the same can be prevented by said

anti-sticking layer, and accordingly, interference patterns & luminosity irregularities arising on a liquid crystal display screen due to sticking can be inhibited.

[0018]

In a case where a backlight unit for a liquid crystal display device designed to disperse beams emitted from a lamp and guide the same to the front surface side thereof is constituted to possess the aforementioned optical sheet, therefore, it becomes possible to dispense with an ITO deposition film, etc. used for liquid crystal display devices of the prior art and accordingly to facilitate attempts to reduce the thickness & weight of the liquid crystal display device and to improve the luminosity of the same.

[0019]

(Application embodiments of the invention)

In the following, application embodiments of the present invention will be explained in detail with reference adventitiously to figures. Figure 1 is a schematic cross-sectional view diagram which shows the optical sheet of an application embodiment of the present invention, whereas Figure 2 is a schematic cross-sectional view diagram which shows the optical sheet of an embodiment different from that of the optical sheet of Figure 1.

[0020]

The optical sheet (1) of Figure 1 is specifically a light diffusion sheet constituted to possess a substrate

layer (2), an optical layer (light diffusion layer) (3) laminated on the front surface of said substrate layer (2), and a metal oxide film (4) laminate on the rear surface of said substrate layer (2).

[0021]

The substrate layer (2) is formed by a transparent, above all colorless & transparent, synthetic resin since it must transmit light. There are no special restrictions on synthetic resins used for said substrate layer (2), and they may, for example, be instantiated by polyethylene terephthalate, polyethylene naphthalate, acrylic resin, polycarbonate, polystyrene, polyolefins, cellulose acetate, weather-resistant vinyl chloride, etc. Of these, polyethylene terephthalate, polyethylene naphthalate, & polycarbonate are especially

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desirable due to advanced heat resistances thereof. For the purpose of improving the heat resistance, dimensional stability, etc., furthermore, it is also possible to disperse & internalize, within the interior of the substrate layer (2), ultrafine inorganic particles of colloidal silica, colloidal aluminum oxide, colloidal calcium carbonate, smectite, mica, titanium oxide, zirconium oxide, antimony oxide, zinc oxide, magnesium oxide, talc, alumina, barium sulfate, asbestos, etc.

[0022]

There are no special restrictions on the thickness (i.e., average thickness) of the substrate layer (2), although it may, for example, be designated at 10 μm or above and 500 μm or below, preferably 35 μm or above and 250 μm or above. In a case where the thickness of the substrate layer (2) is smaller than the aforementioned range, curling is likely to occur on an occasion where a resin composition is coated for forming the optical layer (3), accompanied by the inconvenience of handling difficulty. Conversely, in a case where the thickness of the substrate layer (2) exceeds the aforementioned range, the luminosity of the liquid crystal display device may become attenuated, and furthermore, the enlarged thickness of the backlight unit contradicts the thickness reduction requirement for the liquid crystal display device.

[0023]

The optical layer (3) is constituted by a binder (5) and a light diffusion agent (6) dispersed within said binder (5). The light diffusion agent (6) thus dispersed is capable of diffusing, in virtually homogeneous manners, beams transmitted through the optical layer (3) from rear to front surfaces thereof. In a case where the upper end of the light diffusion agent (6) is induced to protrude from the binder (5), furthermore, beams can be diffused more effectively. Incidentally, there are no special restrictions on the thickness of the optical layer (3) {i.e., thickness of a

binder (5) portion excluding the light diffusion agent (6)}, although it may, for example, be designated at approximately 1 μm or above and 30 μm or below.

[0024]

Synthetic resins used for the binder (5) may, for example, be instantiated by acrylic resins, polyurethanes, polyesters, fluorinated resins, silicone resins, polyamideimides, epoxy resins, etc. Apart from the aforementioned polymer(s), furthermore, it is also possible to mix, with the binder (5), the likes of a plasticizer, stabilizer, anti-degradation agent, dispersant, etc. The synthetic resin used as the binder (5) is mandated to be transparent, above all, colorless & transparent, in acknowledgment of the need to transmit beams.

[0025]

The light diffusion agent (6) consists of particles bearing a beam diffusing profile, and such particles are classified roughly into inorganic fillers & organic fillers. Inorganic fillers are concretely instantiated by silica, aluminum hydroxide, aluminum oxide, zinc oxide, barium sulfide, magnesium silicate, and corresponding mixtures. Organic fillers are concretely instantiated by acrylic resins, acrylonitrile resins, polyurethanes, polyvinyl chlorides, polystyrenes, polyacrylonitriles, polyamides, etc.

[0026]

There are no special restrictions on the shapes of the light diffusion agent (6), and they may, for example, be

instantiated by spherical, cubic, acicular, bar-shaped, bell-shaped, sheet-shaped, flaky, fibrous, etc., and above all, spherical beams are especially desirable since they exhibit excellent light diffusion capacities.

[0027]

It is desirable for the lower limit on the average particle size of the light diffusion agent (6) to be 3 μm, more preferably 5 μm, or most preferably 8 μm, whereas it is desirable for the upper limit on the average particle size of the light diffusion agent (6) to be 35 μm, more preferably 30 μm, or most preferably 25 μm. In other words, in a case where the average particle size of the light diffusion agent (6) is smaller than the aforementioned range, depressions & protrusions formed on the optical layer (3) surface by the light diffusion agent (6) become miniscule, as a result of which it may become impossible to satisfy the light diffusion requirement for the light diffusion sheet, whereas, conversely, in a case where the average particle size of the light diffusion agent (6) exceeds the aforementioned range, the thickness of the optical sheet (1) becomes enlarged, and furthermore, the homogeneous diffusion of light becomes difficult.

[0028]

It is desirable for the lower limit on the mixing ratio of the light diffusion agent (6) {mixing ratio with respect to 100 parts of the polymer content of the binder (5)} to be 0.1 part, more preferably 5 part, or most preferably 10

parts, whereas it is desirable for the upper limit on the mixing ratio of the light diffusion agent (6) to be 500 parts, more preferably 300 parts, or most preferably 200 parts. In other words, in a case where the mixing ratio of the light diffusion agent (6) is lower than the aforementioned range, the light diffusion becomes insufficient, whereas in a case where the mixing ratio of the light diffusion agent (6) exceeds the aforementioned range, the effect of fixing the light diffusion agent (6) becomes attenuated.

[0029]

The metal oxide film (4) is formed by a transparent metal oxide bearing electroconductivity. Usable metal oxides are instantiated by ITO (indium-tin oxide), ATO (antimony-tin oxide), cobalt oxide, tin oxide, titanium oxide, zinc oxide, aluminum oxide, etc. Above all, the ITO is especially desirable as the constituent material of said metal oxide film (4) in that it bears an excellent transparency and a high electroconductivity.

[0030]

There are no special restrictions on methods for forming said metal oxide film (4), and usable methods may, for example, be instantiated by deposition (PVD method), ion plating method, IBD method, IBSD method, IBAD method, sputtering method, chemical plating (non-electrolytic plating), etc. Above all, deposition is especially desirable for the present optical sheet (1) in that it is capable of

forming a thin & dense metal oxide film (4) and of yielding a metal oxide film (4) bearing a high electroconductivity and therefore an advanced electromagnetic wave shield effect. This deposition may be executed based on the vacuum deposition method, sputtering method, etc.

[0031]

Incidentally, the transparency & electroconductivity of a case where the metal oxide film (4) is formed by means of deposition depend vitally on the retention temperature of the substrate layer (2), namely a treatment target substrate, in the course of film formation. In a case where this retention temperature is low, the transparency & electroconductivity become attenuated. The substrate layer (2), on the other hand, is formed by a synthetic resin, as has been mentioned earlier, and it is impossible to designate said retention temperature at 180°C or above, whereas it is difficult to up the transparency & electroconductivity of a metal oxide film (4) deposited at such a retention temperature due to the amorphous state thereof. A method for upping the transparency & electroconductivity of a metal oxide film (4) by irradiating a laser beam after film formation has accordingly been developed (refer, for example, to Japanese Patent Application Publication Kokai No. Hei 10[1998]-12060 Gazette).

[0032]

It is desirable for the lower limit on the surface resistance of the metal oxide film (4) to be 5 Ω/□. It is

desirable, on the other hand, for the upper limit on the surface resistance of the metal oxide film (4) to be 500 Ω/□, above all 250 Ω/□. In other words, in a case where the surface resistance of the metal oxide film (4) exceeds the aforementioned upper limit, the aforementioned electromagnetic wave shield effect becomes attenuated, whereas, conversely, it is necessary, from the standpoint of designating said surface resistance below the aforementioned lower limit value, to up the temperature during the deposition of the metal oxide film (4), as a result of which thermal strains of the substrate layer (2) &

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degradations of the optical layer (3) become incurred, and it becomes difficult to use the light diffusion sheet.

[0033]

Next, the method for manufacturing said optical sheet (1) will be explained. This method for manufacturing said optical sheet (1) possesses (a): A process whereby a metal oxide film (4) is laminated on the rear plane of a substrate layer (2) by depositing a metal oxide, etc., (b): A process whereby an optical layer coating solution is prepared by mixing a light diffusion agent (6) with a resin composition constituting a binder (5), and (c): A process whereby this optical layer coating solution is coated on the front surface of the substrate layer (2) for laminating an optical layer (3).

[0034]

A light diffusion effect is achieved by the optical layer (3) of said optical sheet (1), whereas electromagnetic waves generated from a lamp, etc. can be shielded by the metal oxide film (4) of the same. It therefore becomes possible to prevent inconveniences attributed to leaks of electromagnetic waves, namely flickers on liquid crystal display screens & action errors of other instruments, etc.

[0035]

The optical sheet (11) of Figure 2 is constituted by a substrate layer (2), an optical layer (3) laminated on the front surface of said substrate layer (2), a metal oxide film (4) laminated on the rear plane of the substrate layer (2), and an anti-sticking layer (12) laminated on the rear plane of this metal oxide film (4). Since said substrate layer (2), optical layer (3), & metal oxide film (4) are identical to their counterparts of the application embodiment shown in Figure 1, they are designated to bear identical notations for avoiding overlapping explanations. A light diffusion effect is therefore achieved by the optical layer (3) of said optical sheet (1) [sic: Presumably "(11)"], whereas electromagnetic waves generated from a lamp, etc. can be shielded by the metal oxide film (4) of the same.

[0036]

The anti-sticking layer (12) is constituted by a binder (13) and beads (14) dispersed within said binder (13). The constituent material of the binder (13) may be similar to

that of the binder (5) for the optical layer (3), whereas ones similar to those constituting the light diffusion agent (6) of the optical layer (3) can be used as the beads (14). There are no special restrictions on the thickness of this anti-sticking layer (12) {thickness of the binder (13) portion excluding the beads (14)}, although it may, for example, be designated at approximately 1 μm or above and 10 μm or below.

[0037]

Since the mixing ratio of the beads (14) is relatively low, the respective beads (14) dispersed within the binder (13) are mutually separated. Lower ends of large numbers of the beads (14) protrude, in extremely miniscule manners, from the binder (13). In a case where this optical sheet (11) becomes laminated on a light guide panel, therefore, the lower ends of protruding beads (14) become contacted with the surface of the light guide panel, etc., based on which the contact of the entire rear plane of the optical sheet (11) with the light guide panel, etc. can be avoided. It accordingly becomes possible to prevent the mutual sticking of the optical sheet (11) & the light guide panel, etc. and to inhibit luminosity irregularities of the screen of a liquid crystal display device.

[0038]

Next, the method for manufacturing the optical sheet (11) will be explained. This method for manufacturing said optical sheet (11) possesses (a): A process whereby a metal

oxide film (4) is laminated on the rear plane of a substrate layer (2) by depositing a metal oxide, etc., (b): A process whereby an optical layer coating solution is prepared by mixing a light diffusion agent (6) with a resin composition constituting a binder (5), (c): A process whereby this optical layer coating solution is coated on the front surface of the substrate layer (2) for laminating an optical layer (3), (d): A process whereby an anti-sticking layer coating solution is prepared by mixing beads (14) with a resin composition constituting a binder (13), and (e): A process whereby this anti-sticking layer coating solution is coated on the rear plane of the metal oxide film (4) for laminating an anti-sticking layer (12).

[0039]

In a case where the aforementioned optical sheet (1) or (11) is used as the light diffusion sheet (24) of a backlight unit (20) for the liquid crystal display device shown in Figure 3 (a) constituted by a lamp (21), a light guide panel (22), and optical sheets (23) including the light diffusion sheet (24) & prism sheet (25) and designed to disperse beams emitted from the lamp (21) and guide the same to the front surface side thereof, therefore, electromagnetic waves become shielded by said optical sheet (1) or (11), and it becomes possible not only to dispense with an ITO deposition film, etc. used for liquid crystal display devices of the prior art and but also to facilitate attempts to reduce the thickness &

weight of the liquid crystal display device and to improve the luminosity of the same.

[0040]

Incidentally, the optical sheets of the present invention are not limited to those of the aforementioned application embodiments, and it is possible, for example, to laminate the metal oxide film (4) on the front surface of the substrate layer (2), or such films may also be laminated on both front & rear planes of the substrate layer (2). The metal oxide film (4) may, furthermore, be laminated on the front surface of the optical layer (3) or on the rear plane of the anti-sticking layer (12). Electromagnetic wave shield functions are served by each of these mechanisms. The metal oxide film (4) may, on the other hand, be laminated on the rear or frontal plane of a prism sheet (i.e., prism plane) for serving similar electromagnetic wave shield functions.

[0041]

(Effects of the invention)

As the foregoing explanations have demonstrated, optical layers of the optical sheet of the present invention serve specified optical functions, whereas electromagnetic waves emitted from a lamp, etc. can be shielded by the metal oxide film of the same, as a result of which it becomes possible to prevent inconveniences attributed to leaks of electromagnetic waves, namely flickers on liquid crystal display screens & action errors of other instruments, etc.

[0042]

A backlight unit constituted to possess said optical sheet, furthermore, is capable of dispensing with an ITO deposition film, etc. used for liquid crystal display devices of the prior art by virtue of the electromagnetic wave shield effect ascribed to said optical sheet. As a result, it becomes possible to facilitate attempts to reduce the thickness & weight of the liquid crystal display device and to improve the luminosity of the same.

Brief explanation of the figures

Figure 1: A schematic cross-sectional view diagram which shows the optical sheet of an application embodiment of the present invention.

Figure 2: A schematic cross-sectional view diagram which shows the optical sheet of an embodiment different from that of the optical sheet of Figure 1.

Figures 3: (a) is a schematic oblique view diagram which shows a general edge light-type backlight unit, whereas (b) is a schematic cross-sectional view diagram which shows a general light diffusion sheet.

(Explanation of notations)

(1): Optical sheet;

/6

(2): Substrate layer;

(3): Optical layer;

(4): Metal oxide film;

(5): Binder;

(6): Light diffusion agent;

(11): Optical sheet;

(12): Anti-sticking layer;

(13): Binder;

(14): Beads.

Figure 1

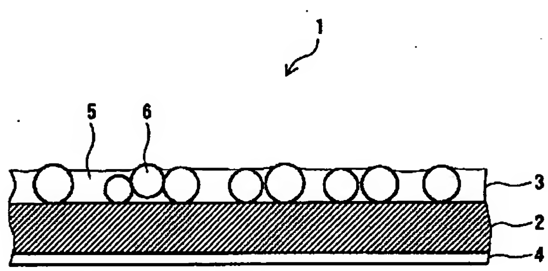
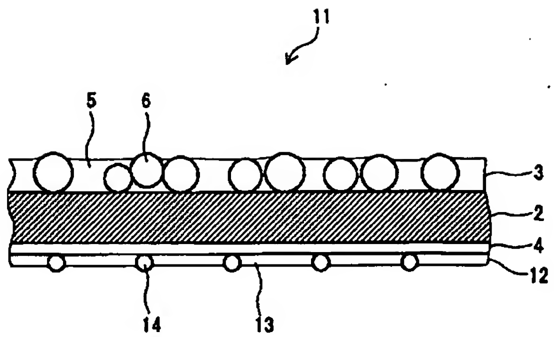
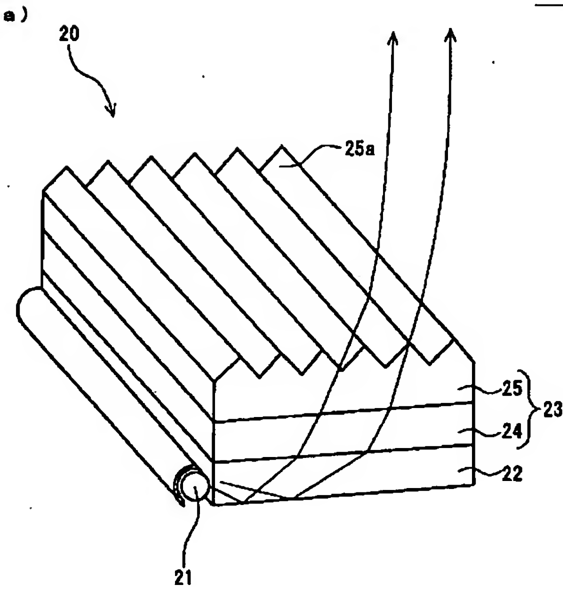


Figure 2



Figures 3

(a)



(b)